IN THE CLAIMS

Please amend claims as follows:

1. (Currently Amended) A method of digitally encoding speech, comprising

generating an excitation function using an excitation module, said excitation function comprising a number of non-zero pulses within an analysis frame separated by spaces therebetween; ~~and~~

generating ~~computing a~~ synthesized speech using a synthesis filter from ~~in response to only~~ said number of non-zero pulses within the analysis frame without contribution from the spaces therebetween~~,~~ ; and

performing synthesis filter optimization, including selecting one of a plurality of excitation functions and selecting roots of the synthesis polynomial for one excitation function that minimizes a synthesis error produced by the synthesis filter.

2. (Original) The method according to claim 1, further comprising optimizing roots of a synthesis filter polynomial using an iterative root optimization algorithm in response to said computed synthesized speech.

3. (Original) The method according to claim 1, wherein said pulses are non-uniformly spaced.

4. (Original) The method according to claim 1, wherein said pulses are uniformly spaced.

5. (Original) The method according to claim 1, wherein said excitation function is generated using a linear prediction coding ("LPC") encoder.

6. (Original) The method according to claim 1, wherein said excitation function is generated using a multipulse encoder.

7. (Original) The method according to claim 1, wherein said spaces comprise no pulses.

8. (Original) The method according to claim 1, wherein said excitation function is generated within an analysis frame comprising a plurality of speech samples; and wherein said synthesized speech is computed in response to said samples which comprise at least one of said pulses and not in response to said samples which comprise none of said pulses.

9. (Previously Presented) The method according to claim 1, wherein said synthesized speech is calculated using the formula:

$$\hat{s}(n) = h(n) * u(n) = \sum_{k=1}^{F(n)} h(n - p(k))u(p(k))$$

wherein $\hat{s}(n)$ is the synthesized speech sample at time n, h(n) is the impulse response of the synthesis filter at time n, u(n) is the excitation function at time n, and p(k) is a location of the k-the excitation pulse in the frame.

10. (Previously Presented) The method according to claim 9, wherein said synthesized speech is further calculated using the formula:

$$\hat{s}(n) = \sum_{k=0}^{n} h(k)u(n-k) = \sum_{k-1}^{F(n)} u(p(k)) \sum_{i=1}^{M} b_i(\lambda_i)^{n-p(k)}$$

where b_i is the i-th decomposition coefficient; and

where said excitation function is defined by the formulas:

$$u(p(k)) \neq 0 \quad \text{for} \quad k = 1,2 \ldots N_p$$

$$u(n) = 0 \qquad \text{for} \quad n \neq p(k)$$

and where F(n) is a number of excitation pulses in an analysis frame up to sample n and is defined by the formulas:

$$p(F(n)) \leq n$$

$F(n)) \leq N_p$, where N_p is the number of excitation pulses in the analysis frame.

11. (Previously Presented) The method according to claim 10, further comprising computing roots of a synthesis polynomial using the formula:

$$\partial\hat{s}(k)/\partial\lambda_r^{(j)} = b_r \sum_{m=1}^{F(k)} (k-p(m))u(p(m))\,(\lambda_r^{(j)})^{(k-p(m)-1)}$$

where λ_r is the r-th root of the synthesis filter, $\lambda_r^{(j)}$ is the r-th root at the j-th iteration, and $\partial\hat{s}(k)/\partial\lambda_r^{(j)}$ is the partial derivative of the k-th synthesized speech sample relative to the r-th root of the synthesis filter at the j-th iteration.

12. (Original) The method according to claim 1, wherein said synthesized speech computation comprises calculating a convolution of an impulse response and said excitation function; and wherein said spaces comprise no pulses.

13. (Previously Presented) The method according to claim 12, wherein said excitation function is generated within an analysis frame comprising a plurality of speech samples; wherein said synthesized speech is computed in response to said samples which comprise at least one of said pulses and is not computed in response to said samples which comprise none of said pulses; and wherein said synthesized speech is calculated using the formula:

$$\hat{s}(n) = h(n) * u(n) = \sum_{k=1}^{F(n)} h(n - p(k))u(p(k))$$

wherein $\hat{s}(n)$ is the synthesized speech sample at time n, h(n) is the impulse response of the synthesis filter at time n, u(n) is the excitation function at time n, and p(k) is a location of the k-th excitation pulse in the frame.

14. (Original) The method according to claim 13, wherein said pulses are non-uniformly spaced; and wherein said excitation function is generated using a multipulse encoder.

15. (Original) The method according to claim 14, further comprising optimizing roots of a synthesis polynomial using an iterative root searching algorithm in response to said computed synthesized speech.

16. (Currently Amended) A method of digitally encoding speech, comprising

producing a series of pulses within an analysis frame, adjacent pulses defining a space therebetween; and

<u>generating</u> ~~computing~~ a synthesis polynomial, said <u>generating the synthesis polynomial</u> ~~computing~~ comprising calculating a contribution of said pulses and not calculating a contribution

of only said space, and including selecting one of a plurality of excitation functions and selecting roots of the synthesis polynomial for the one excitation function that minimizes a synthesis error produced by the synthesis filter.

17. (Previously Presented) The method according to claim 16, wherein said synthesis polynomial computation comprises calculating a convolution of an impulse response and said excitation function; wherein said excitation function is generated within an analysis frame comprising a plurality of speech samples; and wherein said synthesis polynomial is computed in response to said samples which comprise at least one of said pulses and is not computed in response to said samples which comprise none of said pulses; and further comprising optimizing roots of said synthesis polynomial using an iterative root optimization algorithm.

18. (Previously Presented) The method according to claim 17, wherein said synthesis polynomial is calculated using the formula:

$$\hat{s}(n) = h(n) * u(n) = \sum_{k-1}^{F(n)} h(n-p(k))u(p(k))$$

wherein $\hat{s}(n)$ is the synthesized speech sample at time n, h(n) is the impulse response of the synthesis filter at time n, u(n) is the excitation function at time n, and p(k) is a location of the k-th excitation pulse in the frame; and

where said excitation function is defined by the formulas:

$$u(p(k)) \neq 0 \quad \text{for} \quad k = 1,2 \ldots N_p$$

$$u(n) = 0 \quad \text{for} \quad n \neq p(k)$$

and where F(n) is a number of excitation pulses in an analysis frame up to sample n and is defined by the formulas:

$p(F(n)) \leq n$

$F(n)) \leq N_p$, where N_p is the number of excitation pulses in an analysis frame.

19. (Previously Presented) A speech synthesis system, comprising

an excitation module responsive to an original speech and generating an excitation function using an excitation module, said excitation function comprising a series of pulses within an analysis frame; and

a synthesis filter responsive to said excitation function and said original speech and generating a synthesized speech using a synthesis filter; wherein said synthesis filter computes a convolution of an impulse response and said excitation function, said convolution computation comprising calculating samples of speech having only said pulses within the analysis frame; including selecting one of a plurality of excitation functions and selecting roots of the synthesis polynomial for the one excitation function that minimizes a synthesis error produced by the synthesis filter.

20. (Previously Presented) The method according to claim 19, wherein said synthesis filter computes roots of a synthesis polynomial using the formula:

$$\partial\hat{s}(k)/\partial\lambda_r^{(j)} = b_r \sum_{m=1}^{F(k)} (k-p(m))u(p(m))\,(\lambda_r^{(j)})^{(k-p(m)-1)}$$

where λ_r is the r-th root of the synthesis filter, $\lambda_r^{(j)}$ is the r-th root at the j-th iteration, and $\partial\hat{s}(k)/\partial\lambda_r^{(j)}$ is the partial derivative of the k-th synthesized speech sample relative to the r-th synthesis filter at the j-th iteration, where p(m) is a location of the m-th excitation pulse, u(p(m)) is an excitation function at time p(m), and k is a time index.

21. (Previously Presented) The method according to claim 19, wherein said convolution computation is calculated using the formula:

$$\hat{s}(n) = \sum_{k=0}^{n} h(k)u(n-k) = \sum_{k-1}^{F(n)} u(p(k)) \sum_{i=1}^{M} b_i(\lambda_i)^{n-p(k)}$$

where λ_r is the r-th root of the synthesis filter, $\lambda_r^{(j)}$ is the r-th root at the j-th iteration, and $\partial\hat{s}(k)/\partial\lambda_r^{(j)}$ is the partial derivative of the k-th synthesized speech sample relative to the r-th synthesis filter at the j-th iteration, where p(m) is a location of the m-th excitation pulse, u(p(k)) is an excitation function at time p(k), and k is a time index; and

where said excitation function is defined by the formulas:

$$u(p(k)) \neq 0 \quad \text{for} \quad k = 1,2 \ldots N_p$$

$$u(n) = 0 \quad \text{for} \quad n \neq p(k)$$

and where F(n) is a number of excitation pulses in an analysis frame up to sample n and is defined by the formulas:

$$p(F(n)) \leq n$$

$F(n)) \leq N_p$, where N_p is the number of excitation pulses in the analysis frame.

22. (Previously Presented) The method according to claim 19, wherein said convolution computation is calculated using the formula:

$$\hat{s}(n) = h(n) * u(n) = \sum_{k-1}^{F(n)} h(n - p(k))u(p(k))$$

wherein $\hat{s}(n)$ is the synthesized speech sample at time n, h(n) is the impulse response of the synthesis filter at time n, u(n) is the excitation function at time n, and p(k) is a location of the k-th excitation pulse in the frame; and

where said excitation function is defined by the formulas:

$$u(p(k)) \neq 0 \quad \text{for} \quad k = 1,2 \ldots N_p$$

$$u(n) = 0 \qquad \text{for} \quad n \neq p(k)$$

and where F(n) is a number of excitation pulses in an analysis frame up to sample n and is defined by the formulas:

$$p(F(n)) \leq n$$

$F(n)) \leq N_p$, where N_p is the number of excitation pulses in the analysis frame.

23. (Original) The method according to claim 22, wherein said pulses are non-uniformly spaced.

24. (Original) The method according to claim 22, wherein said pulses are uniformly spaced; and wherein said excitation function is generated using a linear prediction coding ("LPC") encoder.

25. (Previously Presented) The method according to claim 22, further comprising a synthesis filter optimizer responsive to said excitation function and said synthesis filter and generating an optimized synthesized speech sample; wherein said synthesis filter optimizer minimizes a synthesis error between said original speech and said synthesized speech; wherein said synthesis filter optimizer comprises an iterative root optimization algorithm; and wherein said iterative root optimization algorithm uses the formula:

$$\partial \hat{s}(k)/\partial \lambda_r^{(j)} = b_r \sum_{m=1}^{F(k)} (k-p(m))u(p(m))\,(\lambda_r^{(j)})^{(k-p(m)-1)}$$

where λ_r is the r-th root of the synthesis filter, $\lambda_r^{(j)}$ is the r-th root at the j-th iteration, and $\partial\hat{s}(k)/\partial\lambda_r^{(j)}$ is the partial derivative of the k-th synthesized speech sample relative to the r-th root of the synthesis filter at the j-th iteration.